Designation: F1696 – 15

An American National Standard

Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines[1]

This standard is issued under the fixed designation F1696; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the evaluation of the energy and water consumption of single-rack, door-type commercial dishwashers (hereafter referred to as dishwashers). Dishwashers may have a remote or self-contained booster heater. This test method does not address cleaning or sanitizing performance.

1.2 This test method is applicable to both hot water sanitizing and chemical sanitizing stationary rack machines, which includes undercounter single rack machines, upright door-type machines, pot, pan and utensil machines, fresh water rinse machines and fill-and-dump machines. Dishwasher tank heaters are evaluated separately from the booster heater. Machines designed to be interchangeable in the field from high temp and low temp (that is, Dual Sanitizing Machines) and vice versa, shall be tested at both settings. Machines should be set for factory settings. If a dishwasher includes a booster heater as an option, energy should be sub metered separately for the booster heater. When the test method specifies to use the data plate or manufacturer's recommendations, instructions, specifications, or requirements, the information source shall be used in the following order of preference and documented in the test report: data plate, user manual, communication with manufacturer.

1.3 The following procedures are included in this test method:

1.3.1 *Procedures to Confirm Dishwasher is Operating Properly Prior to Performance Testing:*

1.3.1.1 Maximum energy input rate of the tank heaters (see 10.3).

1.3.1.2 Maximum energy input rate of the booster heater, if applicable (see 10.4).

1.3.1.3 Water consumption calibration (see 10.5).

1.3.1.4 Booster temperature calibration, if applicable (see 10.2).

1.3.1.5 Tank temperature calibration (see 10.7.6.1 and 10.7.6.2).

1.3.2 *Energy Usage and Cycle Rate Performance Tests:*

1.3.2.1 Washing energy test (see 10.7).

1.3.2.2 Idle energy rate (door(s) open and door(s) closed) (see 10.8).

1.4 The values stated in inch-pound units are to be regarded as standard. The SI units given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3588 Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels

F857 Specification for Hot Water and Chemical Sanitizing Commercial Dishwashing Machines, Stationary Rack Type

F861 Specification for Commercial Dishwashing Racks

F953 Specification for Commercial Dishwashing Machines (Stationary Rack, Dump Type) Chemical Sanitizing

2.2 *NSF Standards:*[3]

NSF/ANSI 3 Commercial Warewashing Equipment

NSF/ANSI 170 Glossary of Foodservice Terms

2.3 *ASHRAE Document:*[4]

ASHRAE Guideline 2-1986 (RA90) Engineering Analysis of Experimental Data

3. Terminology

3.1 *Definitions:*

[1] This test method is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.06 on Productivity and Energy Protocol.

Current edition approved Aug. 1, 2015. Published October 2015. Originally approved in 1996. Last previous edition approved in 2014 as F1696 – 14. DOI: 10.1520/F1696-15.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.

[4] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

3.1.1 *ambient temperature, n*—defined in NSF/ANSI 170-2014; Section 3.3.

3.1.2 *auxiliary rinse, n*—defined in NSF/ANSI 170-2014; Section 3.5.

3.1.3 *average tank temperature, n*—temperature of the wash tank measured within ½ in. of the factory installed thermostat bulb. The temperature is measured and averaged during the 10 rack (6 racks for pot and pan or for undercounter) loaded room temperature washing test. The time interval for averaging includes washing, rinsing, dwell, energy recovery (for heat recovery dishwashers), wash tank temperature recovery and loading. For upright machines, the temperature averaged over the entire period starting with the first loaded dish rack and ending with the elapsed interval period after the last rack is washed. For undercounter machines, the measurement period ends when both wash tank and booster elements cycled off after the last load is washed. Stabilization loads should not be included in the average wash tank temperature.

3.1.4 *booster heater, n*—water heater for taking supply hot water (typically 140°F) up to 180°F for sanitizing rinse; the booster heater may be separate from dishwasher or integral. Booster heater is defined in NSF/ANSI 170-2014; Section 3.224.1.

3.1.5 *chemical dump type machine, n*—a low temp, stationary rack machine with a pumped recirculated sanitizing rinse.

3.1.6 *chemical sanitizing (low temp) machine, n*—a machine that applies a chemical sanitizing solution to the surfaces of dishes to achieve sanitization.

3.1.7 *chemical sanitizing rinse, n*—defined in NSF/ANSI 170-2010; Section 3.170.

3.1.8 *cycle rate, n*—the number of loaded dishracks washed per hour during the Washing Energy Performance test.

3.1.9 *dishwasher, n*—a machine that uniformly washes, rinses, and sanitizes eating and drinking utensils and cookware.

3.1.10 *dual sanitizing machine, n*—a machine designed to operate as either a high temp or low temp machine.

3.1.11 *dwell mode, n*—for stationary rack machines, the dishwasher is in dwell mode when it is actively running a cycle but is not in wash or rinse modes.

3.1.12 *energy saver mode, n*—operational setting that is designed to reduce energy during idle mode through temporary shut-down of certain machine components (pumps or belt motors) or reduction of certain temperature set points.

3.1.13 *factory settings, n*—a setting that has been programmed or adjusted at the factory and is representative of the way that model is set up initially. These settings are the default settings for the machine and may or may not be user adjustable.

3.1.14 *flow pressure, n*—defined in NSF/ANSI 170-2014; Section 3.76.

3.1.15 *fresh water, n*—defined in NSF/ANSI 170-2014; Section 3.85.

3.1.16 *glasswashing, n*—a stationary rack, under counter machine specifically designed to clean and sanitize glasses.

3.1.17 *hot water sanitizing (high temp) machine, n*—a machine that applies hot water to the surfaces of dishes to achieve sanitization.

3.1.18 *hot water sanitizing rinse, n*—defined in NSF/ANSI 170-2010; Section 3.171.

3.1.19 *idle mode, n*—for all dishwasher types, the dishwasher is in idle mode when it is not actively running but is still powered on and ready to wash dishes while maintaining the tank or tanks at the required temperature.

3.1.20 *idle rate, n*—rate of energy consumed by the dishwasher while "holding" or maintaining the heated tank water at the thermostat(s) set point during the time period specified.

3.1.21 *line pressure, n*—defined in NSF/ANSI 170-2014; Section 3.115.

3.1.22 *loads:*

3.1.22.1 *dishload, n*—a peg type, polypropylene dishrack of a specified weight, loaded with ten 9-in. plates of a specified weight, used to put a thermal load on the dishwasher during the washing energy performance test.

3.1.22.2 *glassload, n*—6 glasses by 6 glasses, polypropylene glass rack of a specified weight, loaded with eighteen 8-fl oz (237 ml) glasses, used to put a thermal load on the dishwasher during the washing energy performance test.

3.1.23 *non-recirculating pumped sanitizing rinse, n*—defined in NSF/ANSI 170-2014; Section 3.131.

3.1.24 *post-sanitizing rinse, n*—defined in NSF/ANSI 170-2014; Section 3.174.

3.1.25 *pot, pan, and utensil, n*—a stationary rack, door type machine designed to clean and sanitize pots, pans, and kitchen utensils.

3.1.26 *prewashing unit, n*—defined in NSF/ANSI 170-2014; Section 3.150.

3.1.27 *pumped rinse, n*—defined in NSF/ANSI 170-2014; Section 3.154.

3.1.28 *rack, n*—defined in NSF/ANSI 170-2014; Section 3.157.

3.1.29 *rated temperature, n*—dishwasher's rated data plate minimum operating tank temperature as determined by NSF/ANSI 3.

3.1.30 *recirculating final sanitizing rinse, n*—defined in NSF/ANSI 170- 2014; Section 3.162.

3.1.31 *rinse mode, n*—for stationary rack machines, the dishwasher is in rinse mode when it is at the end of the actively running cycle and is spraying hot water or chemical sanitizing rinse water or a post-sanitizing rinse. If there is a post-sanitizing rinse, it shall be included in rinse mode.

3.1.32 *sanitization, n*—defined in NSF/ANSI 170-2014; Section 3.178.

3.1.33 *sanitizing rinse, n*—defined in NSF/ANSI 170-2010; Section 3.173.

3.1.34 *sanitizing solution, n*—defined in NSF/ANSI 170-2014; Section 3.179.

3.1.35 *stationary rack machine, n*—a dishwashing machine in which a rack of dishes remains stationary within the machine while subjected to sequential wash and rinse sprays. This definition also applies to machines in which the rack revolves on an axis during the wash and rinse cycles.

3.1.36 *tank heater idle energy rate, n*—rate of energy consumed by the dishwasher while "holding" or maintaining the heated tank water at the thermostat(s) set point during the time period specified.

3.1.37 *uncertainty, n*—measure of systematic and precision errors in specified instrumentation or measure of repeatability of a reported test result.

3.1.38 *undercounter dishwasher, n*—Specification F953 Type III machines, a stationary rack machine with an overall height of 38 inches or less, designed to be installed under food preparation workspaces. Under counter dishwashers can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.

3.1.39 *upright door-type dishwasher, n*—Specification F857 Type I (straight through model) and Type II (corner model) and F953 Type I (straight through model) and Type II (corner model) machines, stationary rack machine designed to accept a standard 20 inch × 20 inch dish rack, which requires the raising of a door to place the rack into the wash/rinse chamber. Closing of the door typically initiates the wash cycle. Subcategories of single tank, stationary door type machines include: single rack, double rack, pot, pan and utensil washers, chemical dump type and hooded wash compartment ("hood type"). Single tank, door type models can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.

3.1.40 *user adjustable, n*—a setting that can be adjusted by the operator without tools and can be adjusted without removal of panels. These settings cannot be accessed through password protected service menus that are described in the service manual. These settings can be accessed through menus without passwords and are described in user manuals. Password protection that allows the manager to access the settings is considered user adjustable. Button combinations not described in the user manual are considered passwords.

3.1.41 *washing, n*—defined in NSF/ANSI 170-2014; Section 3.222.

3.1.42 *wash mode, n*—for stationary rack machines, the dishwasher is in wash mode when it is actively running a cycle and is spraying wash water (that is, water that is neither part of the sanitizing rinse, nor post sanitizing rinse).

3.1.43 *water heater, n*—defined in NSF International/American National Standards Institute (NSF/ANSI) 170-2014: Glossary of Food Equipment Terminology; Section 3.224.

4. Summary of Test Method

4.1 The booster temperature (for high temperature machines) and wash tank temperature are calibrated and verified.

4.2 The maximum energy input rate of the tank heater and the booster heater is determined to check whether the dishwasher is operating at the manufacturer's rated input. If the measured input rate is not within 5 % of the rated input or the rating printed on the heating element, all further testing ceases.

NOTE 1—It is the intent of the testing procedure herein to evaluate the performance of a dishwasher at its rated gas pressure or electric voltage. If an electric unit is rated dual voltage (that is, designed to operate at either 208 or 240 volts (V) with no change in components), the voltage selected by the manufacturer or tester, or both, shall be reported. If a dishwasher is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the unit (for example, recovery time) may differ at the two voltages. Therefore the tests may be performed at both voltages and results reported accordingly.

4.3 The water consumption is adjusted to the manufacturer's rated water consumption per NSF/ANSI Standard 3. Report the measured consumption and confirm that it is within 5 % of the NSF rating. If the difference is greater than 5 %, terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the dishwasher or provide another unit for testing.

4.4 The dishwasher energy rate is determined at idle, that is, when the tank temperature(s) is being maintained, but no washing is taking place. This test is run with the door(s) closed (see 10.8).

4.5 The booster heater idle energy rate is determined (see 10.9).

4.6 The dishwasher and booster energy consumption per rack of dishes or glasses is determined by washing racks loaded with a specified quantity of dishes or glasses (see 10.7).

4.7 Water consumption is monitored during testing to determine the rate of water usage.

5. Significance and Use

5.1 The maximum energy input rate test is used to confirm that the dishwasher is operating at the manufacturer's rated input prior to further testing. This test would also indicate any problems with the electric power supply, gas service pressure, or steam supply flow or pressure.

5.2 The tank and booster temperature are verified and water consumption is adjusted to NSF specifications to ensure that the test is applied to a properly functioning dishwasher.

5.3 Because much of a dishwasher's operating period is spent in the idle condition, tank heater and booster idle energy consumption rate is an important part of predicting an end user's energy consumption. The test is run with the door(s) open and with the door(s) closed, so that the energy use of both end-user behaviors can be characterized.

5.4 A washing energy test generates an energy per rack usage. This is useful both as a measure for comparing the energy performance of one dishwasher to another and as a predictor of an end users energy consumption.

5.5 Water-consumption characterization is useful for estimating water and sewage costs associated with dishwashing machine operation.

6. Apparatus

NOTE 2—For all instruments, the specifications may be better than specified. Values provided are intended to be the minimum or maximum (depending on which is the worst case for the parameter) allowable.

6.1 *One or Two watt-hour (Wh) Meters,* for measuring the electrical energy consumption of the tank heaters, pump motor, and booster heater (if applicable), shall have a resolution 10 Wh or better and a minimum accuracy 1.5 % of the measured value for any demand greater than 100 W. For any demand less than 100 watts (W), the meter shall have a resolution of 10 Wh or better and a minimum accuracy of 10 % of the measured value.

6.2 *Gas Meter(s),* for measuring the gas consumption of tank heater or booster heater, or both, shall have a resolution of at least 0.1 cubic feet (ft^3) (0.003 m^3), a minimum accuracy of 1 % of the measured value for any demand greater than 2.2 ft^3/hour (h) (0.06 m^3/h), and shall be capable of measuring flows between at least 0 and 250 ft^3/hour. Pilot light gas consumption should be measured for at least an 8 hour period.

6.3 *One or Two Steam Flow Meters,* for measuring the flow of steam to tank heaters and or booster heater, if applicable. They shall have a resolution of at least 0.01 ft^3 (0.0003 m^3), a maximum accuracy no greater than 1 % of the measured value, and shall be capable of measuring flows between at least 0.0 and 50 ft^3/hour and recording data at least as frequently as every second.

6.4 *Pressure Gauge,* for measuring the pressure of steam to steam coils and steam injector. It shall have a resolution of at least 0.5 pounds per square inch gage (psig) (3.4 kPa), a minimum accuracy of ±1 % of the measured value, and shall be capable of measuring flows between at least 0 and 100 psig.

6.5 *Canopy Exhaust Hood,* mounted in agreement with manufacturer's requirements and operating at the dishwasher manufacturer's recommended ventilation rate, if applicable, or a nominal 300 to 500 cubic feet per minute (cfm) ventilation rate if the manufacturer does not provide a recommended ventilation rate. Report the ventilation rate used for the tests.

6.6 *Pressure Gauge,* for monitoring natural gas pressure. It shall have a range of 0 to 10 inches water (in. H_2O) (0 to 2.5 kPa), a resolution of at least 0.1 in. H_2O (125 Pa), and a maximum accuracy of 3 % of the measured value.

6.7 *Pressure Gauge,* for water consumption test. It shall be capable of measuring at least 0 to 30 pounds per square inch gage (psig) with a resolution of at least 1 psig and a maximum uncertainty of 3% of the measured value.

6.8 *Temperature Sensor,* for measuring natural gas and ambient air temperatures in the range of 50 to 100°F (10 to 40°C), with a resolution of at least 0.5°F (0.3°C) and a minimum accuracy of 1 %.

6.9 *Temperature Sensor,* for measuring steam temperatures for dishwashers with steam coil tank or booster heat, in the range of 200 to 300°F, with a resolution of at least 0.5°F and a maximum accuracy of 1 %.

6.10 *Barometer,* for measuring absolute atmospheric pressure, to be used for adjustment of measured natural gas volume to standard conditions, if the gas flow meter does not correct for pressure, or for calculating absolute pressure from gage pressure if the pressure gauge does not correct for atmospheric pressure for steam coil tank or booster heat. It shall have a resolution of at least 0.2 in. mercury (in. Hg) (670 Pa) and a maximum accuracy of 0.2 in. Hg (670 Pa).

6.11 *Flow Meter,* for measuring water consumption of the dishwasher. The calibrated flow meters shall have a resolution of at least 0.01 gal (40 mL), a maximum accuracy of 1 % full scale and shall be capable of measuring flow rates as low as 0.2 gpm (13 mL/s). The maximum flowrate of the machine should not exceed 90 % of the meter's upper measurement range. If using a data acquisition system, water meters should have the capability of outputting a minimum of 100 pulses per gallon.

6.12 *Stop Watch,* with a 0.1 second (s) resolution and an accuracy of ± 2% of the time period being measured.

6.13 *Analytical Balance Scale,* or equivalent, for measuring weight of dishes or glasses and dish- or glassracks used in the dish load or glassload energy test. It shall have a resolution of at least 0.01 lb (5 g) and a accuracy of 0.01 lb (5 g) or better.

6.14 *Temperature Sensor,* with a range from –20 to 400°F (–30 to 200°C), a resolution of at least 0.2°F (0.1°C), a maximum accuracy of 1 %, and a response time of less than 2 seconds, for measuring tank temperature and booster and dishwasher inlet temperature. For tankless dishwashing machines, the temperature should be measured in the sump. For dishwashing machines with steam coil tank or booster heat, the thermocouple probes shall be used for measuring the condensate water outlet temperature. Calibrated Type K Z4 GA thermocouple wire with stainless steel sheath and ceramic insulation is the recommended choice for booster and dishwasher inlet temperature. The thermocouple probe can be fed through a compression fitting so as to submerse the exposed junction in the booster and dishwasher inlets.

6.15 *Dishracks,* minimum of 10 20 inch (in.) by 20 in., peg type, commercial, or acceptable equivalent (e.g.: Metro Mdl P2MO). Each shall weigh 4.4 ± 0.2 lb and are used in the washing energy performance test.

6.16 *Glassracks,* minimum of 6, 36 glass compartment medium plus, 19¾ by 19¾ in. Six ⅜ in. high with compartments measuring 2⅞ by 2⅞ by 4 13⁄16 in., commercial, or acceptable equivalent. Each shall weigh 4.8 ± 0.2 lb and are used in the washing energy performance test. Polypropylene holding 36 glasses (height).

6.17 *Plates,* minimum of 100, 9 in., ceramic-glazed, weighing 1.3 ± 0.05 lb each. If plates, meeting these criteria cannot be obtained, then it will be necessary to acquire saucers, as specified in 6.19. See 9.11 prior to obtaining these plates.

6.18 *Glasses,* minimum of 108, 8 oz (237 ml) double bulge milk glasses 3⅝ in. in height and 2⅝ in. in diameter (for example: Libbey 618, Anchor/Oneida 7708U), weighing 0.35 lb (159 g) each. If glasses meeting these criteria cannot be obtained, then add or remove no more than one glass per rack that will together equal the required total weight of 5.75 ± 0.25 lb for the glasses alone (i.e., excluding the rack weight).

6.19 *Saucers,* ceramic-glazed, weighing less than 0.5 lb each. See 9.11 for an explanation of why these may be required.

6.20 *Pans,* minimum of 18 aluminum, solid 23 gauge pans, weighing 3.2 lb each with a total weight of 9.6 ± 0.2 lb for 3 pans.

6.21 *Surface Temperature Thermocouple Probe,* for measuring the plate or glass temperature. Resolution and uncertainty shall be the same as in 6.14.

6.22 *Vessel,* for capturing the sanitizing and post-sanitizing rinse water, shall be large enough (depending on the tank volume) to capture the water consumed during the entire water consumption test.

6.23 *Scale,* for water consumption test, shall be capable of measuring at least 0-50 pounds (lb) with a resolution of at least 0.1 lb and an accuracy of ± 0.1 lb or better.

7. Materials

7.1 As specified in 6.15 and 6.16, the dishracks or glassracks must be made of polypropylene. This is required because the test method assumes a specific heat of 0.39 Btu/(lb × °F). One verification that a rack is polypropylene is if it has the recycling symbol No. 5 on it with the letters "PP" below the symbol.

8. Sampling

8.1 *Dishwasher*—A representative production model shall be selected for performance testing.

9. Preparation of Apparatus

9.1 Install the dishwasher in accordance with the manufacturer's instructions under a 3-feet (ft) by 3-ft canopy exhaust hood, operating at a nominal ventilation rate of 100 cfm per linear foot of hood space or in accordance with manufacturer's recommendation, if applicable. Record the ventilation rate used for the testing. The associated heating or cooling system shall be capable of maintaining an ambient temperature of 75 ± 5°F within the testing environment when the exhaust ventilation system is working and the appliance is being operated. All packing material and protective packaging shall be removed. Drain connections shall be accessible with sufficient space to allow capture vessel to be positioned beneath.

9.2 Install the booster heater (if it is not integral to the dishwasher) in accordance with the manufacturer's recommendations. The pipe from the booster outlet to the dishwasher inlet shall be minimized, and shall be wrapped with ½-in. insulation along its entire length.

9.3 Connect the booster to a supply of water that is within the range of the manufacturer specified input temperatures (not to exceed 140 ± 2°F). For condensing heat recovery machines, connect the supply to 70 ± 3°F water. For testing purposes, the dishwasher may be connected to a source of water that is at the manufacturer specified sanitizing rinse temperature in lieu of an external booster heater.

9.4 Connect the dishwasher to a calibrated energy test meter so that all energy (including tank heater, motors, and controls) is monitored. Connect the external booster heater to a separate calibrated energy test meter. For steam coil or gas dishwashers, electric energy consumption shall be simultaneously monitored with steam or gas energy consumption. Internal booster heaters shall be monitored separately and the booster i energy shall be reported separately from the total energy. If it is not possible to measure booster heater energy separately, it shall be included in the total energy consumption.

9.5 For gas installations, install a pressure regulator (downstream from the meter) to maintain a constant (manifold) pressure of gas supplied to the dishwasher and booster heater (if applicable) for all tests. Install instrumentation to record both the pressure and temperature of the gas supplied to the dishwasher and the barometric pressure during each test so that the measured gas flow can be corrected to standard conditions if the gas flow meter does not already correct for pressure and temperature. For steam coil tank or booster heat installations, install instruments to provide dry superheated steam to the dishwasher. Adjust the steam supply pressure to within ±2.5 % of the operating pressure specified by the manufacturer. Install instrumentation to record the pressure, temperature, and volumetric flow rate of the steam supplied to the dishwasher tank heater (and booster heater separately, if applicable), the pressure and temperature of the condensate exiting the dishwasher (and booster heater separately, if applicable), and the barometric pressure during each test so that the measured gage pressures can be corrected to absolute pressure.

9.6 For an electric tank or booster heater, confirm (while the elements are energized) that the supply voltage is within ±2.5 % of the operating voltage specified by the manufacturer. If it is not, a voltage regulator may be required during the tests. Record the test voltage for each test.

9.7 For a gas tank or booster heater, adjust (during maximum energy input) the gas supply pressure downstream from the appliance's pressure regulator to within ±2.5 % of the operating manifold pressure specified by the manufacturer. Make adjustments to the appliance following the manufacturer's recommendations for optimizing combustion, as applicable.

9.8 Install the flow meter (see 6.11) such that total water flow to the booster and dishwasher is measured Install a separate water meter for each water machine connection including any cold water connections.

9.9 Install a temperature sensor (see 6.14) in the wash tank within ½ in. of the factory installed thermostat bulb.

9.10 Install a temperature sensor (see 6.14) in the sanitizing rinse at the inlet to the rinse manifold (usually rinse agent injection port), and in the inlet and outlet of the external booster heater. The sensors should be installed with the probe immersed in the water. If the machine has an internal booster heater and it is not possible to measure rinse temperature directly, a thermocouple should be installed on the outer surface of the booster heater.

NOTE 3—Install the thermocouple probes described in 6.21 into the water inlets for dishwasher rinse and booster. The thermocouple probe shall be installed so that the thermocouple is immersed in the incoming water. A compression fitting should be installed first into the plumbing for both inlets. A junction fitting may be installed in the plumbing line that would be compatible with the compression fitting.

9.11 *Preparation of Dish-Loads (for upright door machines):*

9.11.1 This section describes preparation of 10 dishloads and an empty rack to be used in the washing energy performance test washing energy performance test for upright door machines.

9.11.2 An important feature of the washing energy performance test is that every dishwasher is subjected to the same thermal load. To accomplish this, the tester must control some of the factors that affect the thermal load. These factors are:

9.11.2.1 The total weight of the dishes,

9.11.2.2 The weight of the (empty) racks, and

9.11.2.3 The initial temperature of the dishes and racks.

9.11.3 The weight of the dry dishracks is specified in 6.15 as 4.4 ± 0.2 lb per rack. If they weigh more than 4.6 lb, trim away material until they weigh 4.4 ± 0.2 lb. To see what parts of the rack are not needed for the test and may therefore be trimmed, it may be desirable to load the rack as they will be used during the test. The loading is explained in 9.11.4 and 9.11.5.

9.11.4 Prepare ten dishloads as described in this and the following step (9.11.5). The ten dishloads must have 13.0 ± 0.5 lb of plates. Ideally, this simply requires ten 9-in. plates. If the total weight of the ten 9-in. plates does not fall within the range, then use the saucers to adjust the total weight. A maximum of three saucers can be added per rack.

9.11.5 Space the plates and saucers evenly on the racks. The plate and saucer spacing shall be the same on all racks.

9.11.6 The bulk temperature of the dishloads must be 75 ± 2°F. This can be accomplished by storing the dishloads together in a room with an ambient temperature of 75 ± 2°F. Avoid any circumstances that would result in some dishes being at different temperature from others, such as being stored in the air path of an HVAC supply register. Determine the bulk temperature using a surface temperature probe (6.21), measuring the temperature of three plates (one front, one center, and one rear) of each dishrack. Average these temperatures to determine the bulk temperature.

9.12 *Preparation of Glass-Loads (for undercounter machines):*

9.12.1 This section describes preparation of six glassloads and an empty rack to be used in the washing energy performance test for undercounter dishmachines.

9.12.2 An important feature of the washing energy performance test is that every dishwasher is subjected to the same thermal load. To accomplish this, the tester must control some of the factors that affect the thermal load. These factors are:

9.12.2.1 The total weight of the glasses,

9.12.2.2 The weight of the (empty) racks, and

9.12.2.3 The initial temperature of the glasses and racks.

9.12.3 The weight of the dry glassracks is specified in 6.16 as 4.8 ± 0.2 lb per rack. If they weigh more than 5.0 lb, trim away material until they weigh 4.8 ± 0.2 lb. To see what parts of the rack are not needed for the test and may therefore be trimmed, it may be desirable to load the rack as they will be used during the test. The loading is explained in 9.12.4 and 9.12.5.

9.12.4 Prepare six glassloads as described in this and the following step (9.12.5). The six glassloads must have 5.75 ± 0.25 lb of glasses. Ideally, this simply requires eighteen glasses described in 6.18. If the total weight of the eighteen glasses does not fall within the range, then add or remove no more than one glass per rack.

9.12.5 Insert the glasses inverted and spaced evenly in the rack. The glass spacing shall be the same on all racks.

9.12.6 The bulk temperature of the glassloads must be 75 ± 2°F. This can be accomplished by storing the glassloads together in a room with an ambient temperature of 75 ± 2°F. Avoid any circumstances that would result in some glasses being at different temperature from others, such as being stored in the air path of an HVAC supply register. Determine the bulk temperature using a surface temperature probe (6.21), measuring the temperature of at least three glasses (one front, one center, and one rear) of each glassrack. Average these temperatures to determine the bulk temperature.

9.13 *Preparation of Pan-Loads (for pot and pan machines):*

9.13.1 This section describes preparation of six pan loads and an empty rack to be used in the washing energy performance test for pot and pan machines.

9.13.2 An important feature of the washing energy performance test is that every dishwasher is subjected to the same thermal load. To accomplish this, the tester must control some of the factors that affect the thermal load. These factors are:

9.13.2.1 The total weight of the pans,

9.13.2.2 The weight of the (empty) racks, and

9.13.2.3 The initial temperature of the pans and racks.

9.13.3 The same racks should be used for pot and pan dishwashers as the dish racks. The weight of the dry pan rack is specified in 6.15 as 4.4 ± 0.2 lb per rack. If they weigh more than 4.6 lb, trim away material until they weigh 4.4 ± 0.2 lb. To see what parts of the rack are not needed for the test and may therefore be trimmed, it may be desirable to load the rack as they will be used during the test. The loading is explained in 9.13.4 and 9.13.5.

9.13.4 Prepare six pan loads as described in this and the following step (9.13.5). The six pan loads must have 9.6 ± 0.2 lb of sheet pans. Ideally, this simply requires three aluminum sheet pans described in 6.20.

9.13.5 Insert the three pans vertically and spaced evenly in the rack. The pan spacing shall be the same on all racks.

9.13.6 The bulk temperature of the pans must be 75 ± 2°F. This can be accomplished by storing the pan load together in a room with an ambient temperature of 75 ± 2°F. Avoid any circumstances that would result in some pans being at different temperature from others, such as being stored in the air path of an HVAC supply register. Determine the bulk temperature using a surface temperature probe (6.21), measuring the temperature of each pan per rack. Average these temperatures to determine the bulk temperature.

10. Procedure

10.1 *General:*

10.1.1 Obtain and record the following for each run of every test (gas, electric, and steam coil units).

10.1.1.1 Voltage while elements are energized, and

10.1.1.2 Measured peak input rate during or immediately prior to test (does not include motor starting load).